U.S. Fish & Wildlife Service

Draft Post-Delisting Monitoring Plan for the Tinian Monarch

(Monarcha takatsukasae)

Tinian Monarch at its nest

Photo courtesy of Tim Sutterfield, U.S. Navy

Recommended Citation:
U.S. Fish and Wildlife Service. 2004. Draft Post-delisting Monitoring Plan for the Titian Monarch *Monarcha takatsukasae*. Endangered Species Division, Pacific Island Fish and Wildlife Office, Honolulu, HI. 19 pp.

Table of Contents

Acknowledgments ii

Background 1

Justification, Purpose, and Objectives 4

Implementation 5

Methods 7
- A. Monitoring the Tinian Monarch 7
  - 1. Roadside Point Count Surveys 7
  - 2. Small-Scale Early Warning System Plots 8
  - 3. Large-Scale Variable Circular Plot Survey 10
  - 4. Habitat Specific Demographic Study (not required) 11
- B. Monitoring the Brown Treesnake 12
  - 1. Monitoring 12
  - 2. Interdiction Recommendations (not required) 12
- C. Monitoring Land Use on Tinian 13

Reports, Analyses, and Listing Triggers 14

Literature Cited 16

Acknowledgments

This monitoring plan was developed by the U.S. Fish and Wildlife Service (Service) in cooperation with the U.S. Geological Survey Biological Resources Division, the U.S. Department of Agriculture Wildlife Services, the U.S. Navy, and the Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife. Effective implementation of this post-delisting monitoring plan will be achieved only through the cooperation of these same partners. Dr. Eric VanderWerf, the Service's Hawaiian Bird Recovery Coordinator, was the primary author. Assistance and valuable comments on drafts of this plan were provided by Fred Amidon, Jon Bart, Earl Campbell, Tina de Cruz, Holly Freifeld, Leila Gibson, Curt Kessler, Michael Lusk, Annie Marshall, Gad Perry, Gordon Rodda, Haldre Rogers, Derek Stinson, Tim Sutterfield, Scott Vogt, and Gary Wiles.

Background

Tinian is a small [101 square kilometers (39 square miles)] island in the Commonwealth of the Northern Mariana Islands (CNMI), and is located three islands to the north of Guam. The human population of Tinian was estimated at 3,540 during a census in 2000. The majority of residents live in the island's only town of San Jose at the southwestern edge of the island. The northern 71 percent of the island is leased to the U.S. Department of Defense (USDOD) for defense purposes. The remaining 29 percent of the island is divided between leased public property (67 percent), privately owned property (26 percent), and other public property (7 percent) (Deborah Fleming, CNMI Division of Public Lands, pers. comm. 1999). Approximately 10 percent of the island is devoted to agriculture, while another 30 to 50 percent is used for cattle grazing (Engbring *et al.* 1986, Belt-Collins 1994).

The Tinian monarch (*Monarcha takatsukasae*), or Chuchurican Tinian in Chamorro, was described by Takatsukasa and Yamashina (1931). It is a small [15 centimeter (6 inch)] forest bird in the monarch flycatcher family (Monarchidae), and has light rufous underparts, olive-brown upperparts, dark brown wings and tail, white wing bars, and a white rump and undertail coverts (Baker 1951). The monarch currently is found only on the island of Tinian, but examination of museum specimens by Peters (1996) suggested a now extirpated population may have occurred on the island of Saipan, just north of Tinian. The monarch also was reported from the tiny island of Aguiguan just south of Tinian in the early 1950s, but some authorities discount this report as an error (Engbring *et al*. 1986).

Heavy disturbance of Tinian's native forests began in the 18th century when the Spaniards used Tinian as a supply island for Guam and maintained large herds of cattle and other ungulates on the island (Fosberg 1960). In 1926, a Japanese company leased the entire island and cleared additional forested lands for sugarcane production (Belt-Collins 1994). During World War Two (WW II), the sugarcane plantations and most remaining native vegetation were destroyed by military campaigns and military construction (Baker 1946). After the war, the USDOD may have seeded the island with tangantangan (*Leucaena leucocephala*), a rapidly growing tree that is not native to the Marianas, to slow erosion (U.S. Fish and Wildlife Service [USFWS or Service] 1995, 1996). Currently, the vegetation on Tinian is highly disturbed, with tangantangan thickets being the most abundant habitat type (Fosberg 1960; Engbring *et al*. 1986; Falanruw *et al*. 1989). Engbring *et al*. (1986) estimated that 38 percent of Tinian was dominated by tangantangan, while Falanruw *et al*. (1989) estimated that 54 percent of the island was covered in secondary vegetation, which included tangantangan thickets. Only 5 to 7 percent of the island is estimated to support native forest, which is restricted to steep limestone escarpments (Engbring *et al*. 1986; Falanruw *et al*. 1989).

The monarch inhabits a variety of forest types on Tinian, including native limestone forest dominated by figs (*Ficus* species [spp.]), *Elaeocarpus joga, Mammea odorata, Guamia mariannae, Cynometra ramiflora, Aglaia mariannensis, Premna obtusifolia, Pisonia grandis, Ochrosia mariannensis, Neisosperma oppositifolia, Intsia bijuga, Melanolepis multiglandulosa, Eugenia* spp., *Pandanus* spp., *Artocarpus* spp., and *Hernandia* spp., secondary vegetation consisting primarily of the non-natives *Acacia confusa, Albizia lebbeck, Casuarina equisetifolia,*

Cocos nucifera, and *Delonix regia*, with some native species mixed in, and nearly pure stands of introduced tangantangan (Engbring *et al*. 1986; USFWS 1996).

The Tinian monarch was listed as endangered in 1970 (35 FR 8491) under the authority of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668cc). The monarch's status remained as endangered under the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 *et seq*.). The decision to list the monarch as endangered was based on a report by Gleize (1945) of 40-50 monarchs on Tinian after WW II (52 FR 10890), but it is not clear if this report represented the number of birds seen, or an estimate of the total population on the entire island. Pratt *et al*. (1979) suggested that this estimate represented only the number of birds observed by Gleize in a specific part of the island. Downs (1946) reported that monarchs were restricted in distribution to distinct locations on the island, while Marshall (1949) considered the monarch to be abundant. Based on these reports it seems likely that monarchs were common in the small patches of remaining forest, but that their distribution must have been restricted and their population must have been small because so much of the forest had been destroyed. In the late 1970s, Pratt *et al*. (1979) estimated monarchs to number in the tens of thousands and to prefer tangantangan thickets. In May 1982, the Service conducted forest bird surveys of the Mariana islands using variable circular plot methods, during which the monarch was found to be the second most abundant bird species on Tinian, with a population estimated at 39,338 birds and distributed throughout the island in all forest types (Engbring *et al*. 1986). Engbring *et al*. (1986) recommended reassessment of the monarch's endangered status, and on November 1, 1985, the Service published in the *Federal Register* a proposed rule to delist the Tinian monarch (50 FR 45632). Based on comments received, the Service instead chose to downlist the monarch, and a final rule reclassifying the monarch from endangered to threatened was published in the *Federal Register* on April 6, 1987 (52 FR 10890). There is no recovery plan specifying delisting criteria for the Tinian monarch.

A life history study of the Tinian monarch was conducted by the Service in 1994 and 1995 (USFWS 1996). That study showed that monarchs forage and nest in native limestone forest, secondary forest, and tangantangan forest, but found some evidence indicating native limestone forest may be higher quality habitat for monarchs than secondary and tangantangan forests. Monarch home ranges were four to five times smaller in native limestone forest [1,221 square meters (1,460 square yards)] than in secondary forest [5,126 square meters (5,608 square yards)] and tangantangan forests [6,385 square meters (7,636 square yards)], and population densities were higher in native limestone forest [30.7 birds per hectare (12.4 birds per acre)] than in secondary forest [7.7 birds per hectare (3.1 birds per acre)] or tangantangan forest [6.0 birds per hectare (2.4 birds per acre)]. Native tree species may have been preferred for nesting, and nesting success may have been higher in native limestone forest than in secondary and tangantangan forests, but additional information is required to confirm these patterns. Based on the results of that study, the island-wide monarch population was estimated to be approximately 52,904 birds, and a recommendation was made to reassess the threatened status of the monarch (USFWS 1996).

The Service conducted a second survey of the avifauna on Tinian in August and September 1996, using the same transects and methods as in 1982 (see Figure 1). The 1996 survey estimated the monarch population at 55,721 birds (Lusk *et al*. 2000), which was

significantly higher than the estimate of 39,338 birds found by Engbring *et al*. (1986). The 1996 survey also found that vegetation density had increased significantly in all forest types since 1982. Lusk *et al*. (2000) hypothesized that the increase in the monarch population was related to increases in density of vegetation in both native and introduced forest habitats, which may have been related to a decrease in grazing pressure.

On February 3, 1997, we received a petition from the National Wilderness Institute to delist the Tinian monarch. We also received a similar petition dated December 6, 1997, from Juan C. Tenorio & Associates, Inc. (Tenorio). As explained in our 1996 Petition Management Guidance (Service 1996), subsequent petitions are treated separately only when they are greater in scope or broaden the area of review of the first petition. The Tenorio petition provided no additional or new information than what was already provided in the NWI petition and will, therefore, be treated as a comment on the first petition received. On February 22, 1999, we published in the *Federal Register* a notice of petition finding and a proposed rule to remove the Tinian monarch from the Federal List of Endangered and Threatened Wildlife (64 FR 8533). We received two letters of comment on the proposed delisting rule, one of which was from a scientific peer reviewer, and both supported the delisting of the Tinian monarch. On September 21, 2004, we published a final rule removing the Tinian monarch from the Federal List of Endangered and Threatened Wildlife (69 FR 56367). That final rule was based on information from population surveys and demographic research, which indicated that the monarch has increased in number or is at least stable, that the primary listing factor, loss of habitat, has been ameliorated, and that the species is not currently threatened by any other factors.

The future survival of the monarch is dependent on the availability of sufficient forest habitat. Monitoring of land use and forest clearing on Tinian therefore is necessary to help establish whether the monarch is threatened by the destruction, modification, or curtailment of its habitat or range.

The brown treesnake is not known to be established on Tinian at this time and thus is not currently affecting the monarch, but establishment of the brown treesnake (*Boiga irregularis*) on Tinian would threaten the monarch and all other wildlife of Tinian. This nocturnal snake is native to northern Australia, New Guinea, and adjacent islands, and was accidently introduced to Guam in the late 1940s or early 1950s during military operations (Savidge 1987). The brown treesnake is a serious predator because it climbs exceptionally well and forages opportunistically on a wide variety of vertebrates, including birds and their eggs, reptiles, and mammals (Rodda *et al*. 1999a). It has few competitors and no known predators in the Marianas, and can reach population densities of up to 80-120 snakes per hectare (32-48 snakes per acre) (Rodda *et al*. 1999b). On Guam, predation by the brown treesnake decimated the avifauna, causing the local extirpation or complete extinction of 10 of the 13 native forest bird species on the island (Savidge 1987, Conry 1988, Rodda *et al*. 1999a). Declines in bird populations on Guam occurred extremely rapidly once the brown treesnake became established (Savidge 1987, Wiles *et al*. 2003).

There have been at least seven reports of snakes on Tinian from May 12, 1994, to November 9, 2003 (Hawley 2002, Haldre Rogers, USGS brown treesnake rapid response team, pers. comm. 2003). None of the snakes were captured to confirm identification, but several of

the descriptions were consistent with brown treesnakes. Cargo shipments from Guam associated with development and resort construction, and the planned expansion of the Tinian airport, could accidentally introduce brown treesnakes to Tinian. The suspected establishment of an incipient brown treesnake population on Saipan provides another potential source from which snakes could reach Tinian (Hawley 2002). Effective interdiction programs are needed to reduce the chance of brown treesnakes reaching Tinian. If brown treesnakes reach Tinian, immediate action is required to prevent their establishment and the subsequent decline and possible extinction of the Tinian monarch in the wild. It is therefore vitally important to detect and eradicate any incipient populations of brown treesnakes before they become established on the island. Effective brown treesnake interdiction is crucial to the continued survival of the Tinian monarch, regardless of whether the monarch is listed.

Justification, Purpose, and Objectives

Section 4(g)(1) of the Act, added in the 1988 reauthorization, requires the Service to implement a system, in cooperation with the States, to monitor for no fewer than 5 years the status of all species that have recovered and been removed from the List of Threatened and Endangered Wildlife and Plants (50 CFR 17.11, 17.12, 224.101, and 227.4). The purpose of this post-delisting monitoring (PDM) is to verify that a species delisted due to recovery remains secure from risk of extinction after it has been removed from the protections of the Act. The PDM fulfills the final process of species recovery.

Section 4(g) of the Act explicitly requires cooperation with the States in development and implementation of PDM programs, but the Service remains responsible for compliance with section 4(g) and therefore must remain actively engaged in all phases of PDM. The Service also should seek active participation of other entities that are expected to assume responsibilities for the species' conservation post-delisting or have natural resources management mandates.

In keeping with that mandate, the Service developed this draft PDM plan in cooperation with the CNMI Division of Fish and Wildlife (DFW), the U.S. Geological Survey Biological Resources Division (USGS-BRD), the U.S. Department of Agriculture Wildlife Services (USDA-WS), and the U.S. Navy. This plan has been reviewed by several independent scientific experts, including biostatisticians. A 30-day public comment period on this PDM plan was opened with the publication of a Notice of Availability in the *Federal Register* on December 13, 2004. The *Federal Register* notice and the draft PDM plan also were posted on our Endangered Species Program's national web page (http://endangered.fws.gov/) and the web page of the Pacific Islands Fish and Wildlife Office (http://pacificislands.fws.gov/). The final PDM plan and any future revisions also will be posted on these web pages.

We intend to monitor the status of the Tinian monarch in cooperation with the CNMI DFW, the USGS-BRD, the USDA-WS, and the U.S. Navy, through regular field surveys of the distribution and abundance of the monarch, regular field surveys for brown treesnakes on Tinian, and tracking of land use and development on Tinian. If data from this monitoring effort or from some other source indicate that the Tinian monarch is experiencing significant declines in abundance or distribution, that its survival or territory occupancy are declining significantly, or that it requires protective status under the Act for some other reason, the Service can initiate

procedures to re-list the monarch, including, if appropriate, emergency listing.

Implementation

Post-delisting monitoring is a cooperative effort between the Service, state, and foreign governments; other Federal agencies; and nongovernmental partners. Funding of post-delisting monitoring presents a challenge for all partners committed to ensuring the continued viability of the Tinian monarch following removal of ESA protections. To the extent feasible, the Service intends to provide funding for post-delisting monitoring efforts through the annual appropriations process. Nonetheless, nothing in this Plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation.

The Pacific Region (Region 1) of the Service has the lead responsibility for this monitoring effort, but assistance from and collaboration with the U.S. Navy, the CNMI government, particularly the DFW, and the USGS-BRD are crucial for its successful implementation. In addition, assistance from the USDA-WS through contracts from other agencies will be an important component of monitoring of brown treesnakes on Tinian as part of this PDM plan, and for effective interdiction of brown treesnakes throughout the CNMI. There is no recovery team or recovery coordinator for the Tinian monarch; the Pacific Islands Fish and Wildlife Office (PIFWO) has responsibility within the Service for the Mariana islands, and biologists in the PIFWO therefore will take the lead in PDM plan implementation.

The role of the PIFWO is to:

- produce a draft PDM plan for initial review;
- obtain peer review of the draft PDM plan from scientific experts and cooperators and incorporate their comments into the draft PDM Plan;
- write the notice of availability of the draft PDM plan for publication in the *Federal Register*;
- produce a press release for the draft PDM plan;
- distribute the draft PDM plan to interested parties through the Endangered Species Program and PIFWO web sites and by request;
- consider all comments on the draft PDM plan and produce the final PDM plan;
- distribute the final PDM plan to all cooperators;
- determine budget requirements to carry out the monitoring;
- coordinate variable circular plot surveys for the monarch along previously established transects on Tinian;
- coordinate mist-netting, banding, and monitoring of monarchs in early warning plots;
- track projects affecting land use on Tinian;
- compile all survey results and coordinate their analysis;
- ensure that survey methods prescribed in the PDM plan are followed;
- prepare interim and final reports for distribution to all cooperators and interested parties;
- coordinate any meetings or conference calls to discuss monitoring results and their interpretation.

The role of the U.S. Navy is to:

- assist with conducting quarterly roadside point count surveys on Tinian;
- assist with relocating and clearing previously established transects on Tinian;
- assist with conducting Variable Circular Plot (VCP) surveys along previously established transects on Tinian;
- assist with mist-netting, banding, and monitoring of monarchs in the early warning plots;
- continue to provide adequate funding for brown treesnake interdiction measures associated with military training on Tinian.

The role of the CNMI Division of Fish and Wildlife is to:

- assist with conducting semiannual roadside point count surveys on Tinian;
- assist with relocating and clearing previously established VCP transects on Tinian, as workload allows;
- assist with conducting VCP surveys along previously established transects on Tinian, as workload allows;
- assist with mist-netting, banding, and monitoring of monarchs in the small scale early warning plots, as workload allows;
- maintain snake traps at ports and quarantine yards on Tinian and support visual and dog team surveys;
- communicate with the PIFWO about any projects that will significantly reduce the amount of native limestone forest and other forest on Tinian.

The role of the U.S. Geological Survey Biological Resources Division is to:

- assist with conducting VCP surveys along previously established transects on Tinian, as workload allows (Kilauea Field Station, Hawaii);
- assist with analysis of VCP survey data, including estimation of population size and trend (Kilauea Field Station, Hawaii);
- coordinate monthly surveys for brown treesnakes on Tinian and provide technical assistance for response to any reports of snakes on Tinian (Marianas-based staff of the Fort Collins Science Center);
- coordinate development and validation of a dog team trained to detect low density snake populations in forested areas.

Methods

A. MONITORING THE TINIAN MONARCH

Monitoring of the Tinian monarch will occur over a 5-year period from 2005-2010, and will be achieved through three complementary survey methods. First, roadside point counts based on the North American Breeding Bird Survey methodology will be used to monitor the abundance and distribution of monarchs across the island. Second, an "early warning system" consisting of small scale study plots will be used to annually measure survival and territory occupancy of individually color-banded monarchs in areas where brown treesnakes might be most likely to occur, such as near the airport, commercial port, cargo off-loading and staging areas, and developments that are the ultimate destination of cargo received from other islands. Third, a large scale island-wide survey using variable circular plot will be conducted at the end of the 5- year monitoring period in 2010 to assess the species' overall status and to allow evaluation of long-term trends in population size and distribution through comparison with two previous variable circular plot surveys of the avifauna on Tinian (Engbring *et al*. 1986, Lusk *et al*. 2000).

In addition, this plan briefly describes the methods needed for a rigorous scientific study of habitat-specific demography of the Tinian monarch. Though not required to monitor the monarch's status and recovery, habitat-specific demographic information about the monarch would allow more accurate assessment of the amount and distribution of different forest habitats needed for long-term persistence of monarch populations, and would allow more meaningful evaluation of how the species' survival might be affected by development and habitat loss in the future. A similar study was conducted previously (USFWS 1996), but the methods used in that study limit the interpretation of certain results, and additional information is needed to confirm some patterns.

1. Roadside Point Count Surveys

The primary tool for monitoring the status of the Tinian monarch will be point count surveys using methods similar to those of the Breeding Bird Survey, which has been widely used to monitor status of bird populations in North America since 1966 (Sauer *et al*. 2001). Similar surveys also have been used to monitor status of the endangered Mariana crow (*Corvus kubaryi*) on Rota (Plentovich *et al*. in prep.). To produce data that are comparable over time, the same route and the same stations should be used each year, and surveys should be conducted only during the first 5 hours after sunrise and only during favorable weather conditions (*i.e.*, no more than light rain and wind not exceeding Beaufort scale 4). If possible, counts should be made simultaneously by two independent observers to allow assessment of inter-observer variation, and observers must be trained to recognize by sight and sound all species of birds present on Tinian.

These surveys should be conducted at least biannually (twice a year), but quarterly surveys (four times per year) or even monthly surveys are preferable because they would provide more frequent assessment of the monarch population status and

would help avoid potential biases caused by seasonal detectability and disruption of the normal monarch breeding cycle by typhoons. One survey should be conducted during the peak of the typical breeding season in May (USFWS 1996). If surveys are conducted quarterly, other surveys should occur at three-month intervals thereafter in August, November, and February.

Breeding Bird Survey point counts usually are conducted along roads, but whether this is appropriate on Tinian will depend on whether sufficient roads are available that pass through forest habitat suitable for the monarch. The route should sample habitats that are representative of the entire island and that are likely to be accessible and to provide monarch habitat in the future. In North America, the standard length of Breeding Bird Survey routes is 24.5 miles, and this length should be used on Tinian if possible, but it may be shortened if insufficient roads are available. Trails may be substituted for roads, although this could require more time to complete surveys. Sampling stations should be located at 0.5-mile intervals along the route, so that a 24.5-mile route would contain 50 stations. A 3-minute point count should be conducted at each station, during which all birds heard or seen within 0.25 mile of the station should be recorded. Changes in abundance over time should be assessed by using a *t*-test to compare the mean number of monarchs recorded per station each year at the same season, with standard error having degrees of freedom equal to the number of stations minus one. This approach assumes that stations are random samples of monarch habitat on Tinian.

2. Small-Scale Early Warning System Plots

Small-scale monitoring of monarch populations in sensitive areas will serve as an early warning system that predation by brown treesnakes or some other factor may be threatening the monarch. This early warning system will involve identifying study plots near sites of potential brown treesnake introduction, mist-netting and color-banding adult monarchs in those plots, and then re-visiting the plots annually to measure adult survival and territory occupancy. Pacific island monarch flycatchers generally are nonmigratory, territorial year-round, and long-lived (Robertson *et al*. 1994, Sanders *et al*. 1995, VanderWerf 1998, 2004). A sensitive method of measuring short-term local trends in monarch populations is through the rate of turnover in territorial adults (VanderWerf and Smith 2002). In the Cook Islands, nest predation by rats (*Rattus rattus*) was identified as the primary threat to the Rarotonga monarch (*Pomarea dimidiata*) by measuring survival of banded birds (McCormack and Kunzle 1990, Robertson *et al*. 1994). In the Hawaiian Islands, elepaio (*Chasiempis sandwichensis*) populations that were experiencing high rates of adult mortality due to predation (VanderWerf and Smith 2002) and disease (VanderWerf 2001) were identified rapidly by the low survival of territorial adults and the high proportion of young birds in the breeding population. Passive survey methods like the variable circular plot and Breeding Bird Survey are less likely to detect initial population declines, especially if there are a large number of non-breeding “floaters” that fill the vacant territories left by birds that have been depredated. The method proposed here is more likely to quickly reveal early stages of brown treesnake predation or other

threats and would provide valuable baseline data on the survival rate of Tinian monarchs under normal conditions when the population is stable or increasing.

In order to provide an effective early-warning system for brown treesnake predation, plots must be placed strategically near areas most likely to receive brown treesnakes, such as the airport, commercial port, quarantine sites, cargo off-loading zones or staging areas, and sites that are the ultimate destination of materials brought from other islands, like the appliance store that received cargo containing several snakes from Guam in 1995. Due to the current manner in which sea and air cargo are transported and distributed on Tinian, it will be challenging to pinpoint sites where the risk is greatest. Creation of quarantine sites or cargo zones would greatly aid in the interdiction of brown treensnakes, and such sites could be used as foci for monitoring potential brown treesnake predation on Tinian monarchs. The number of early warning plots and their locations will depend on the number of sites identified by experts as most likely to receive brown treesnakes.

The purpose of the early-warning monitoring system is to detect population declines at an early stage, so an objective was set of detecting an absolute decline in survival or territory occupancy of 20 percent or more per year. The sample sizes needed to detect such declines were determined by statistical power analyses. The ability of a statistical test to correctly distinguish between samples from two potentially different populations, such as survival rates before and after snake predation, is called the power of the test. In statistical terms, power is the probability of correctly rejecting the null hypothesis when it is false. The complement, erroneously accepting the null hypothesis when it is false, is called a type II error. In general, a decrease in the type II error rate results in an increase in the type I error rate (the probability of erroneously rejecting the null hypothesis when it is true), producing a trade-off between the two error rates (Sokal and Rohlf 1981, p. 168). In the case of the Tinian monarch, the consequences of making a type II error (accepting the null hypothesis of no decline when a decline actually is occurring) are more severe than the consequences of making a type I error (rejecting the null hypothesis of no decline when there really is no decline). Therefore, in designing the monitoring program a liberal approach was taken, and the desired power was set at 80 percent, or a type II error rate of 20 percent.

There are no data available on annual survival rates of the Tinian monarch, but in the Rarotonga monarch and the elepaio annual survival averages 80 percent and 81 percent, respectively, in the absence of predation by alien species (Robertson *et al.* 1994, VanderWerf and Smith 2002, VanderWerf 2004). These related monarchs are behaviorally and ecologically similar to the Tinian monarch, so it is reasonable to use 80 percent as an initial baseline estimate of annual survival for the Tinian monarch. Given the desired power of 80 percent, in order to detect a decline in survival or territory occupancy from 80 percent to 60 percent (a 20 percent absolute decline), a minimum of 21 banded birds or territories is required each year (Sokal and Rohlf 1981, p. 766). Therefore, on the initial visit to each plot, at least 21 territories should be identified based on the presence of monarchs, and at least 21 adults within those territories should be mist-netted and banded with a unique combination of colored leg bands. In subsequent

years, each territory should be revisited to determine whether it is still occupied and whether the banded birds are still present. Visits should occur from April through June, when monarchs usually are actively nesting and easiest to detect (USFWS 1996). If necessary, playbacks of recorded Tinian monarch vocalizations can be used to lure birds into a net for banding, and to locate birds more efficiently on subsequent visits to measure survival (Falls 1981, Johnson *et al*. 1981, VanderWerf *et al*. 2001). Some natural mortality of banded birds is to be expected, and each year additional birds should be mist-netted and banded to restore the sample of banded birds to at least 21 individuals.

Estimates of survival and territory occupancy from subsequent years can be compared to the baseline estimate to determine if there has been a decline, which might be associated with predation by brown treesnakes or other factors. If there is no indication that survival or territory occupancy has declined from baseline conditions, then data from each year can be added to the baseline estimates. If, however, survival or territory occupancy shows a downward but statistically insignificant trend, then data from each year should be kept separate and should not be pooled across years until it can be shown that the decline was temporary and values rebounded in subsequent years. For example, if the survival rates in the first and second years do not differ much (*e.g.*, 80 percent and 75 percent), then data from these years could be combined, thereby producing a larger baseline sample (n = 40) and providing for more powerful tests in the future. If, however, survival rates in the first two years differ by more than 5 percent, but are not significantly different, (*e.g.*, 80 percent and 70 percent), then the data should be kept separate until the survival rate again approaches 80 percent, indicating the decline was temporary and probably due to factors other than brown treesnake predation, which presumably would result in a long-term reduction in survival. The accumulation of baseline data with each successive monitoring season will produce progressively larger sample sizes and greater statistical power to detect declines in survival in future years. Estimates of survival and territory occupancy should be calculated separately for each early warning plot and compared to the baseline individually because sites may be affected differently by predation and this information is needed to identify where incipient snake populations might exist.

3. Large-Scale Variable Circular Plot Surveys

At the end of the 5-year monitoring period in 2010, a single variable circular plot survey will be conducted to assess the species' overall status and to allow evaluation of long-term trends in population size and distribution through comparison with the two previous surveys of the avifauna on Tinian (Engbring *et al*. 1986, Lusk *et al*. 2000). To facilitate comparison of population estimates over time, surveys should use the same variable circular plot methods and the same 10 transects and 216 stations used in previous surveys (Engbring *et al*. 1986, Lusk *et al*. 2000). These transects are located 2 kilometers (1.24 miles) apart, with sampling stations at 150 meter (492 feet) intervals along each transect (Figure 1). Locations of all stations should be recorded using a Global Positioning System (GPS) unit so they can be overlaid on vegetation maps in order to calculate population density by habitat type. Surveys should be conducted during the first 5 hours after sunrise, and only during favorable weather conditions (*i.e.*,

no more than light rain and wind not exceeding Beaufort scale 4). At each station the distance from the observer to each individual of all bird species (not just monarchs) should be recorded for a period of 8 minutes, and the following additional information also should be recorded: starting time, cloud cover to nearest 10 percent, wind speed category on Beaufort scale, and vegetation density index in one of five categories (1 = complete forest canopy and dense understory with < 15 meter (49 feet) lateral visibility in all directions; 2 = complete or mostly complete forest canopy and 15-50 meter (49-164 feet) lateral visibility in all directions; 3 = complete or mostly complete forest canopy and > 50-meter visibility in all directions; 4 = fragmented forest and > 50 meter (164 feet) visibility in < 50 percent of the surrounding area; and 5 = fragmented forest and >50 meter (164 feet) visibility in > 50 percent of the surrounding area). Transects should be adequately cleared prior to surveys so that observers can move quickly and quietly along transects. This will help minimize disturbance and the effect of observers on the behavior of birds being surveyed and reduce violations of the assumptions of variable circular plot methodology.

The timing of surveys differed in previous monitoring efforts (May in 1982, August-September in 1996), and a reviewer of the proposed delisting rule questioned whether the increase in number of monarchs reported from 1982 to 1996 could have been caused by the difference in timing of surveys. Detectability of birds often varies seasonally and with other factors, and can influence estimates of abundance (Freifeld *et al*. 2004). The timing of all future surveys should be consistent to avoid potentially confounding effects of season on detectability of birds and number of juveniles present. Reproduction varies substantially among years in two related species of monarch flycatchers, the Rarotonga monarch and the elepaio (Robertson *et al*. 1994, VanderWerf and Smith 2002, VanderWerf 2004), thereby producing short-term fluctuations in the number of non-breeding juveniles and subadults among years. It is therefore most appropriate to survey monarch populations early in the breeding season when adults are easiest to detect and the number of juveniles and subadult floaters is smallest. The peak in nest building by the Tinian monarch occurs in May (USFWS 1996), so May seems to be the most appropriate month for surveys.

4. Habitat-Specific Demographic Study (recommended)

This plan proposes to monitor changes in land use and forest extent on Tinian (see section C below) to help ascertain whether sufficient forest remains to support monarch populations, but it does not propose to investigate demography of the Tinian monarch in different forest types. However, habitat-specific demographic information about the monarch would allow better assessment of the amount and distribution of different forest habitats needed for long-term persistence of monarch populations, and would allow more meaningful evaluation of how the species' survival might be affected by development and loss of certain forest types or areas in the future. A rigorous scientific study of this type would require collection of the following data in native limestone forest, secondary forest, and tangantangan habitats: survival rates of adult males, adult females, and juveniles; rate of nest success and, more importantly, number of offspring produced each year per breeding pair; age at first reproduction; rates of dispersal into or out of each

forest type, and accurate estimates of territory or home range size that are not biased by distribution of habitats or size of study plots. This information should be collected in each of at least two replicate plots in each forest type to avoid pseudoreplication. Some of this information was collected in a previous study (USFWS 1996), but many of the results were affected by methodological limitations and additional data is required to confirm some of the patterns suggested by that study.

B. MONITORING THE BROWN TREESNAKE

For the purposes of this plan, there is an important distinction between monitoring of the brown treesnake and interdiction of the brown treesnake. Monitoring involves the periodic collection of data on the abundance of the brown treesnake in order to assess the threat of brown treesnake predation on the Tinian monarch. Interdiction involves measures designed to prevent the brown treesnake from reaching Tinian and becoming established on the island. Examples of interdiction measures include quarantine yards, cargo inspections, dog teams trained to detect snakes, and snake trapping. This post-delisting monitoring plan outlines a monitoring program for brown treesnakes on Tinian, which presently does not exist, and, although interdiction of the brown treesnake is not strictly part of the monitoring plan for the Tinian monarch, this plan also makes recommendations for improving existing brown treesnake interdiction programs that are already in place in the CNMI and on Guam. Effective brown treesnake interdiction is crucial to the continued survival of the Tinian monarch, regardless of whether the monarch is provided protection under the Act.

1. Monitoring

The monitoring program for brown treesnakes on Tinian consists of two components: 1) a field crew trained on Guam to search for brown treesnakes on Tinian, composed of three technicians and one crew leader, who conduct standardized visual surveys for a total of at least 25 hours per month per person in different portions of the island, and who are on call for rapid response to any reports of snakes on Tinian; and 2) a one-half time dog team trained to detect snakes by smell in forested areas that have low-density snake populations. This monitoring program should be supported by a system of snake traps that are regularly maintained at strategic locations, such as the airport and quarantine yard at the commercial port.

2. Interdiction (recommended)

In addition to the monitoring described above, the following interdiction measures are important for preventing the brown treesnake from arriving on Tinian and becoming established, which would constitute a serious threat to the monarch:

a) Construction of a brown treesnake barrier and quarantine yard at the commercial port on Tinian. In FY 2004, the Service provided funds ($200,000) for the construction of this barrier, similar in design to the recently completed barrier on Saipan, which is 3000 square meters (32,400 square feet) in size, has four-foot tall walls with a

one-foot lip, and can accommodate up to 40 containers or break bulk cargo, with parking bumpers to protect the walls from damage (N. Hawley, pers. comm. 2004).

b) Commitment from the U.S. Department of Defense for continued funding to support adequate brown treesnake interdiction associated with military training in the CNMI, which is contracted to the U.S. Department of Agriculture Wildlife Services.

c) Continued support from the U.S. Office of Insular Affairs for base funding of brown treesnake interdiction at the commercial port and airport on Guam and in the CNMI;

d) Financial support from the U.S. Department of Transportation and the CNMI government for adequate brown treesnake interdiction at the Tinian airport and on Saipan.

C. MONITORING LAND USE ON TINIAN

In addition to monitoring the monarch itself and the brown treesnake, monitoring land use on Tinian also is relevant to assessing the recovery of the Tinian monarch. The monarch originally was listed as endangered due to small population size and restricted distribution resulting from loss of forest habitat prior to and during WW II. Subsequent regeneration of forest habitat has allowed the monarch to recover, and monitoring the amount of forest on Tinian will help evaluate whether the monarch population may again be threatened by habitat loss.

Several mechanisms already exist for tracking possible impacts of projects to the environment and natural resources on Tinian. Potential environmental impacts of major Federal projects must be reviewed under the National Environmental Policy Act (NEPA). Environmental Assessments and Environmental Impact Statements for such projects are reviewed by the Service. Impacts of Federal projects on the amount or quality of forest habitat available to the Tinian monarch thus can be tracked through these incoming documents.

The Sikes Act Improvement Act of 1997 (Sikes Act) requires each military installation that includes land and water suitable for the conservation and management of natural resources to complete an Integrated Natural Resources Management Plan (INRMP), which integrates implementation of the military mission of the installation with stewardship of the natural resources found there. Each INRMP provides an assessment of the ecological needs on the installation, including needs to provide for the conservation of listed species, a statement of goals and priorities, a detailed description of management actions to provide for these ecological needs, and a monitoring and adaptive management plan. The military develops each INRMP in collaboration with the Service, and with State, territorial, or commonwealth resource management agencies.

The INRMP for military training in the Marianas includes several projects designed to increase the amount of forest on Tinian and that will enhance and monitor habitat suitable for the Tinian monarch (USDOD 2003, p. 106). These projects include: 1) reforestation on military leased lands using native tree species; 2) planting of native forest understory species to improve

habitat for threatened and endangered species and enhance biodiversity; 3) a vegetation survey that will map, describe, and verify in the field the vegetation communities on military leased lands; and 4) establishment of long-term natural resource monitoring plots on military leased lands.

Non-Federal projects, such as those undertaken by Commonwealth or local governments, do not require review under NEPA, and their potential impacts may be more difficult to track. In these cases assistance from biologists with the CNMI and the U.S. Navy who visit Tinian more frequently and are familiar with local conditions will be necessary in order to effectively gather adequate information on potential impacts to forest habitats.

Previous surveys of the avifauna on Tinian estimated forest density at each sampling station (Engbring *et al*. 1986, Lusk *et al*. 2000). This information proved to be a valuable tool for monitoring extent and density of forest habitat, and the delisting rule was based in part on information gathered during these surveys, which showed an increase in forest density since WW II. Future surveys on Tinian, including the variable circular plot survey in 2010 and the more frequent point count surveys, should continue to collect information about extent and density of forest cover.

Reports, Analyses, and Listing Triggers

Annual reports summarizing the activities, data collected, and results of each component of the PDM plan should be submitted by cooperators to the PIFWO. These reports must be prepared and reviewed in a timely manner to ensure that adequate data are being collected, to allow evaluation of the efficacy of the monitoring programs and their modification if necessary, and to allow periodic assessment of the status of the monarch. The PIFWO will compile all results and, after discussion with cooperators if necessary, synthesize an overall report that will be distributed to all cooperators. Each annual report will comment on the status of the monarch relative to the need for relisting.

Declines in bird populations on Guam due to predation by the brown treesnake occurred very rapidly (Wiles *et al*. 2003). If monitoring reveals that brown treesnakes are reproducing on Tinian or that the frequency and/or distribution of brown treesnake reports are increasing to an extent that the snake appears to be established on Tinian, such evidence would constitute new information that the monarch is in danger of extinction due to predation, and would trigger commencement of listing procedures, possibly including emergency listing if appropriate.

If results from any of the three methods of monitoring the monarch (point counts, early warning plots, and the Variable circular plot survey) indicate that a decline may have occurred, then the cooperators will review all available monitoring data, evaluate possible causes of the apparent decline, and determine the most appropriate response. The monarch population could decline for a number of reasons other than loss of habitat or predation by brown treesnakes, and it will be important to consider the effects of potentially confounding factors, such as poor weather conditions during surveys, disruption of typical monarch breeding phenology by unusual climatic events, and short-term reductions in monarch survival or population size associated with typhoons or local disturbance. Results of the variable circular plot survey conducted in 2010

will be compared to results of previous variable circular plot surveys, which estimated the monarch population to be 39,338 birds in May 1982 (Engbring *et al*. 1986) and 55,721 birds in August-September 1996 (Lusk *et al*. 2000). If the population estimate from the 2010 survey is significantly lower than 39,338 or 55,721 birds at the same season, suggesting a decline, and results are not confounded by the factors listed above, then the data should be examined transect by transect to determine where the decline occurred and what may have caused it. Likewise, if results of point counts indicate that abundance has declined significantly or the results of early warning plots indicate survival or territory occupancy has declined, then the data should be examined geographically to determine where decline(s) occurred. Any areas identified in this way should be targeted for more intensive brown treesnake visual surveys and trapping and for more intensive investigation of monarch demography to determine the cause of decline. If a significant decline in relative abundance or survival persists for 2 consecutive years, then relisting the monarch may be warranted, even if the establishment of brown treesnakes has not been confirmed.

Large scale loss of forest habitat also could require that steps be taken to ensure the long-term survival of the monarch. If results of land use tracking indicate that the range of the monarch is declining due to loss of forest habitat, then actions should be taken to ensure that continued habitat loss does not threaten the monarch with extinction. Such actions include, but are not limited to: candidate conservation agreements; conservation easements; habitat enhancement in alternative areas; and expansion of the 379 hectares (936 acres) "1994 leaseback land" set aside south of the Exclusive Military Use Area as a conservation area for the protection of endangered and threatened wildlife, particularly the Tinian monarch (Tenorio and Associates 1998; USA and CNMI 1999).

At the end of the 5-year monitoring period in 2010, a final report summarizing the results of the monitoring effort will be prepared, the availability of which will be published in the *Federal Register*. The final report should be suitable for publication in a peer-reviewed scientific journal, and will include a discussion of whether monitoring should continue beyond the 5-year period for any reason. If the results are inconclusive, monitoring should continue and the monitoring plan should be modified as appropriate. If there is no indication that the monarch population has declined during the 5-year monitoring period, no reason to believe that it will decline in the foreseeable future, and no reason to believe that the chance of brown treesnake introduction will increase in the foreseeable future, then monitoring can be discontinued at that time. However, predation by brown treesnakes will remain a potential threat to the Tinian monarch until the possibility that snakes are introduced to Tinian has been removed, and brown treensnake interdiction measures, therefore, must continue until that time.

Literature Cited

Baker, R. H. 1946. Some effects of the war on the wildlife of Micronesia. Transactions of the Eleventh North American Wildlife Conference, 1946. American Wildlife Institute, Investment Building, Washington, D.C.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Publications, Museum of Natural History 3:1-359.

Belt-Collins. 1994. Environmental Assessment - military exercise, island of Tinian: Tandem Thrust 95. Prepared for Commander, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, HI. 248 pp.

Conry, P. J. 1988. High nest predation by brown tree snakes on Guam. Condor 90:478-482.

Downs, T. 1946. Birds on Tinian in the Marianas. Trans. Kansas Acad. Sci. 49:87-106.

Engbring, J., F. Ramsey, and V. J. Wildman. 1986. Micronesian Forest Bird Survey, 1982: Saipan, Tinian, Agiguan, and Rota. U.S. Fish and Wildlife Service, Honolulu, HI. 143 pp.

Falanruw, M. C., T. G. Cole, and A. H. Ambacker. 1989. Vegetation survey of Rota, Tinian, and Saipan, Commonwealth of the Northern Mariana Islands. Resour. Bull. PSW-27. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture. 11 pp. plus 13 maps.

Falls, J. B. 1981. Mapping territories with playback; an accurate census method for songbirds. Studies in Avian Biology 6:86-91.

Fosberg, F. R. 1960. The vegetation of Micronesia. Bull. Am. Mus. Nat. Hist. 119:1-75.

Freifeld, H. B., C. Solek, and A. Tualaulelei. 2004. Temporal variation in forest bird survey data from Tutuila Island, American Samoa. Pacific Science 58:99-117.

Gleize, D. A. 1945. Field Notes. Birds of Tinian. Bull. Mass. Audubon Soc. 29:220.

Hawley, N. 2002. CNMI-DFW Brown Tree Snake (BTS) Interdiction Program Report, July 2002.

Johnson, R. R., B. T. Brown, L. T. Haight, and J. M. Simpson. 1981. Playback recordings as a special avian census technique. Studies in Avian Biology 6:68-75.

Lusk, M., S. Hess, M. Reynolds, and S. Johnston. 2000. Population status of the Tinian Monarch (*Monarcha takatsukasae*) on Tinian, Commonwealth of the Northern Mariana Islands. Micronesica 32:181-190.

Marshall, J. T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam, and Palau. Condor 51:200-221.

McCormack, G., and J. Kunzle. 1990. Kakerori, Rarotonga's endangered flycatcher. Cook Islands Conservation Service.

Peters, D. S. 1996. *Monarcha takatsukasae* (Yamashina 1931) - ein Nachweis von Saipan (Aves: Monarchidae). Senckenbergiana Biologica 76:15-17.

Plentovich, S., J. M. Morton, J. Bart, R. Camp, M. Lusk, N. Johnson, and E. A. VanderWerf. In review. Current and historical population status of the Mariana crow on Rota, Commonwealth of the Northern Mariana Islands. Biological Conservation.

Pratt, H. D., P. L. Bruner, and D. G. Berrett. 1979. America's unknown avifauna: the birds of the Mariana Islands. American Birds 33(3):227-235.

Robertson, H. A., J. R. Hay, and E. K. Saul. 1994. Recovery of the Kakerori: an endangered forest bird of the Cook Islands. Conservation Biology 8:1078-1086.

Rodda, G. H., T. H. Fritts, M. J. McCoid, and E. W. Campbell. 1999a. An overview of the biology of the brown treesnake (*Boiga irregularis*), a costly introduced pest on Pacific islands. Pp. 44-80 *in* Problem Snake Management: the Habu and the Brown Treesnake (G. H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, eds.). Cornell University Press, Ithaca, New York.

Rodda, G. H., M. J. McCoid, T. H. Fritts, and E. W. Campbell. 1999b. Population trends and limiting factors in *Boiga irregularis*. Pp. 236-253 *in* Problem Snake Management: the Habu and the Brown Treesnake (G. H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka, eds.). Cornell University Press, Ithaca, New York.

Sanders, K. H., E. O. Minot, and R. A. Fordham. 1995. Juvenile dispersion and use of habitat by the endangered Kakerori *Pomarea dimidiata* (Monarchinae) on Rarotonga, Cook Islands. Pacific Conservation Biology 2:167-176.

Sauer, J. R., J. E. Hines, and J. Fallon. 2001. The North American Breeding Bird Survey, Results and Analysis 1966 - 2000. Version 2001.2. USGS Patuxent Wildlife Research Center, Laurel, MD.

Savidge, J. A. 1987. Extinction of an island forest avifauna by an introduced snake. Ecology 68:660-668.

Sokal, R. R., and F. J. Rohlf. 1981. Biometry, second edition. W. H. Freeman, New York.

Takatsukasa, S. and Y. Yamashina. 1931. Some new birds from the Palau and Mariana islands. Dobutsu Zasshi 43:484-487.

Tenorio, J.C. and Associates, Inc. 1998b. Biological assessment for airport improvements at Tinian international airport island of Tinian Commonwealth of the Northern Mariana Islands. 5 Chapters.

United States of America and Commonwealth of the Northern Mariana Islands. 1999. Dedication of Tinian military retention area land for wildlife conservation.

United States Fish and Wildlife Service. 1995. Biological opinion: Voice of America Mariana relay station project, Tinian, Commonwealth of the Northern Mariana Islands. 17 pp.

United States Fish and Wildlife Service. 1996. Wildlife research report for navy-leased lands on the island of Tinian, CNMI. Prepared for Department of the Navy, PACNAVFACENGCOM, Pearl Harbor, HI. 100 pp.

VanderWerf, E.A. 1998. ‘Elepaio (*Chasiempis sandwichensis*). *In* The Birds of North America, No. 344 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists’ Union, Washington, D.C.

VanderWerf, E. A. 2001. Distribution and potential impacts of avian poxlike lesions in ‘Elepaio at Hakalau Forest National Wildlife Refuge. Studies in Avian Biology 22:247-253.

VanderWerf, E. A. 2004. Demography of Hawai`i `Elepaio: variation with habitat disturbance and population density. Ecology 85:770-783.

VanderWerf, E. A., and D. G. Smith. 2002. Effects of rodent control on demography of the O`ahu `Elepaio, an endangered Hawaiian forest bird. Pacific Conservation Biology 8:73-81.

Vogt, S. 1998. Brown tree snake program in the CNMI. Unpublished report to the Brown Tree Snake Control Committee of the Aquatic Nuisance Species Task Force as part of a brown tree snake coordination meeting, March 16-17, 1998, Honolulu, HI. 4 pp.

Wiles, G. J., J. Bart, R. E. Beck, Jr., and C. F. Aguon. 2003. Impacts of the brown tree snake: patterns of decline and species persistence in Guam's avifauna. Conservation Biology 17:1350-1360.

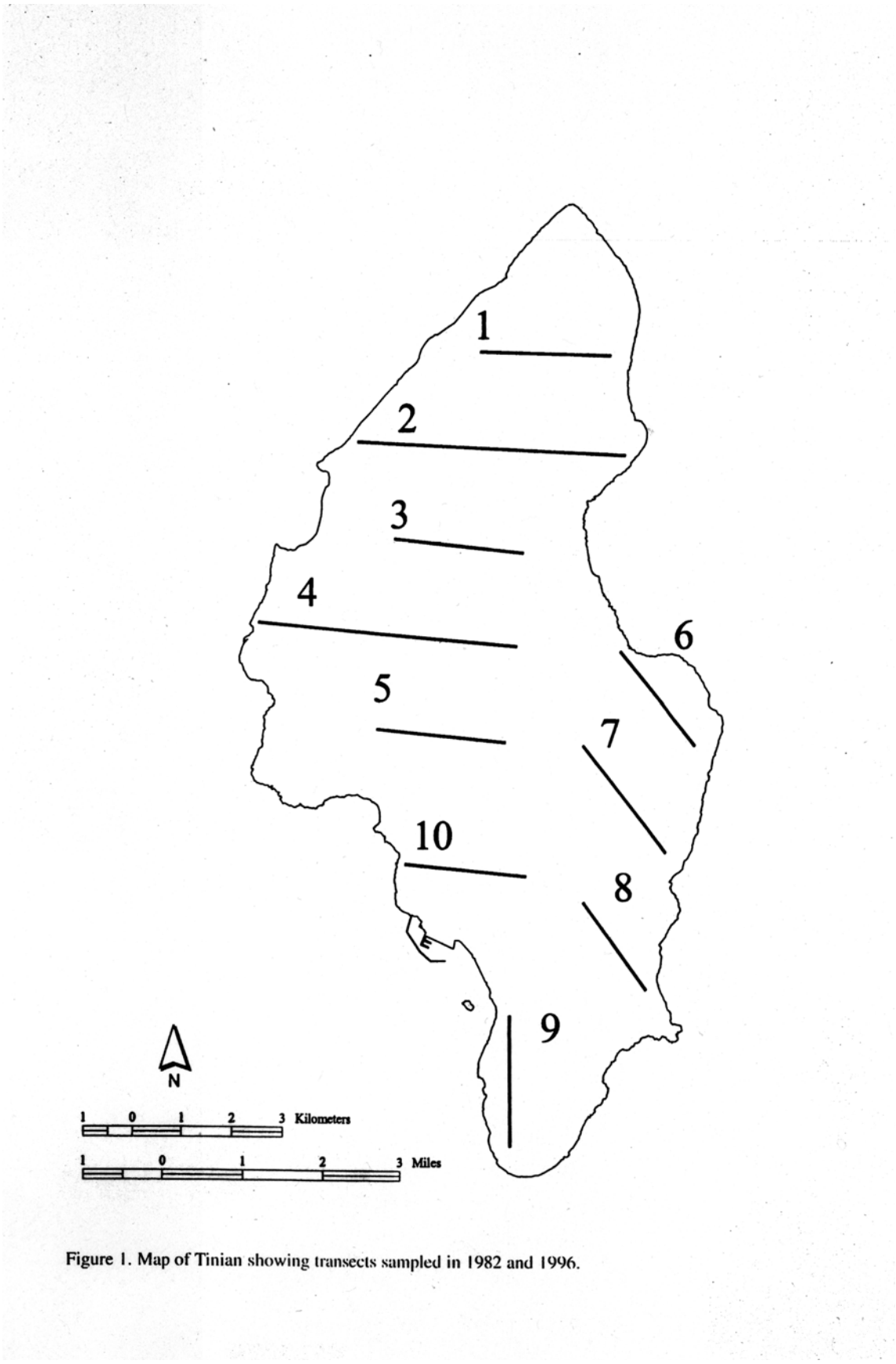

Figure 1. Map of Tinian showing transects sampled in 1982 and 1996.